Ex Ante Evaluation Report

3. Partner P4 BSU - Belarusian State University

3.1. Information about the national education system in the Republic of Belarus

3.1.1. General information

According to the Code of Education (adopted in December 2, 2010 by the House of Representatives and approved in December 22, 2010 by the Council of Republic of Belarusian Parlaiment), currently in the Republic of Belarus is defined:

- basic education,
- additional education,
- special education (education and training of trained who are persons with special needs).

Basic education in Republic of Belarus includes the following levels:

- preschool education;
- secondary education;
- vocational training;
- secondary special education;
- higher education;
- post-graduate education.

General secondary education is level of primary education aimed at the spiritual, moral and physical development of personality (the individual student), preparing it for a full life in society, mastering the students the fundamentals of science, the state languages of the Republic of Belarus, skills, mental and physical labor, the formation of moral beliefs, culture of behavior, aesthetic taste and a

healthy lifestyle, readyness for independent life choices, beginning of employment and continuating of education.

General secondary education includes three stages:

I stage - primary education (I - IV classes);

II stage - basic education (V - IX classes);

III stage - secondary education (X - XI classes, in evening schools - X - XII classes, evening classes - X - XII classes).

I and II stage of secondary education are the basic general education. Basic education allows one to continue training at the levels of vocational education and secondary special education.

I, II and III stages of secondary education are the basic education. General secondary education allows one to continue training at the levels of vocational education, secondary specialized education and higher education.

Terms[1] of secondary education:

general basic education - nine years;

general secondary education - eleven years.

Terms of training on the general secondary education stages are as follows:

at the stage I - four years;

at the stage II - five years;

at the stage III - two years.

Vocational education is the level of basic education aimed at developing the student's personality, his professional formation, receiving a special theoretical and practical training, culminating in qualification of workers with vocational technical education, an employee with vocational technical education.

Date of receipt of technical and vocational education:

based on a common basic education without obtaining a general secondary education or vocational education - from one to two years;

[1] Hereinafter, terms of training are given for full-time education. In the case of correspondence education, etc. terms are able to be changed.

on the basis of basic general education with general secondary education - from two years to six months to three years;

on the basis of secondary education - from one year to two years.

Specialized secondary education is the level of basic education, aiming at the development of the personality of the individual student or trainee, the receiving a special theoretical and practical training by them, culminating in qualification “Specialist” with secondary specialized education, worker with secondary specialized education

The terms for secondary vocational education:

on the basis of basic general education with general secondary education - from three to four years;

on the basis of secondary education - from two to three years;

based on vocational technical education with general secondary education - from one year to three years.

Higher education is the level basic education aimed at developing the personality of student, cadet or listener, their intellectual and creative abilities, receiving of a special theoretical and practical training by them, culminating in qualification “Specialist” with higher education or a master's degree.

Higher education is divided into two stages.

The I stage of higher education provides training of specialists who possess fundamental and special knowledge, skills and abilities with awarding them qualification “Specialist” with higher education.

Higher education of stage I gives the right to continue their education at the II stage of higher education and employment in the received specialty (the direction of specialty, specialization) and qualification.

The II stage of higher education (Masterships) provides in-depth training of specialist, forming of knowledge, practices and skills in teaching and research work with the assignment of a master's degree.

The II stage of higher education is directed on realization of educational programs for stage II higher education, forming the knowledge, practices and skills in teaching and research work to obtain a master's degree, and education program of for stage II higher education with in-depth training of specialist to obtain a master's degree.

The II stage of higher education gives graduates the right to continue their education at post-graduate education (post-graduate studentship or PhD level, see below) and employment in the specialty (the direction of specialty, specialization) and appropriate qualifications.

The term of the Stage I higher education for full-time education is four to five years.

The term of the Stage I higher education for the mostly complicated professions, defined by the Government of the Republic of Belarus, may be increased but not more than on one year.

The term of the Stage II higher education is from one to two years.

Persons with higher education are eligible to continue their education at post-graduate (PhD) level, see below.

Post-graduate education is the level of basic education, aiming at the development of the personality of graduate (PhD) student, adjunct, doctoral student or applicant and the realization of their intellectual and creative potential, development of professional skills in management and carrying out of scientific research, including the assignment of ending academic qualification "Reseacher."

Post-graduate education includes two levels:

Post-graduate studentship (adjuncture) is the I level of postgraduate education, aimed at training professionals with the skill of independent planning and doing of research, deep theoretical knowledge allowing to prepare the qualifying scientific work (thesis) for the degree “Candidate of sciences” (like PhD). The level I of postgraduate education program in post-graduate studentship provides obtaining a scientific qualification "Reseacher";

Doctorate is the II level of postgraduate education, aimed at training professionals with the skills which allows to organize research work on the new direction of science or development of existing topical areas of research, analytical generalization of scientific results, allowing one to prepare the qualifying scientific work (PhD thesis) of Doctor of Sciences (like Doctor habil.). In the level II of postgraduate education, a special doctoral program is implemented.

The term of receipt of postgraduate education is not more than three years.

3.1.2. Assessment Criteria

Indicative criteria for evaluating knowledge and skills of students within the 10-point scale:

10 points:

• systematic, profound and comprehensive knowledge in all the volume of the curriculum, as well as on the major issues to be beyond;

• accurate use of scientific terminology (including a foreign language), stylistically competent and logically correct answers on questions;

• perfect possession of the tools of the discipline, the ability to use it effectively in the formulation and solution of scientific and professional tasks;

• expressed ability to independent and creative solving of complex problems in a precarious situations;

• full and deep understanding of basic and additional literature, which is recommended by curriculum of subject;

• the ability to navigate in the theories, concepts and directions in the study discipline and to give them a critical evaluation, the use of scientific achievements in other disciplines;

• creative independent work on practical and laboratory classes, active participation in group discussions, a high level of culture in execution of tasks.

9 points:

• systematic, profound and comprehensive knowledge in all the volume of the curriculum;

• accurate use of scientific terminology (including a foreign language), stylistically competent and logically correct answers on questions;

• possession of the tools of the discipline, the ability to use them effectively in the formulation and solution of scientific and professional tasks;

• the ability to independent and creative solving of complex problems in a precarious situations in the curriculum, full understanding of basic and additional literature, which is recommended by curriculum on subjects;

• ability to navigate the major theories, concepts and directions in the study discipline and to give them a critical evaluation;

• independent work on practical and laboratory classes, creative participation in group discussions, a high level of culture in execution of tasks.

8 points:

• systematic, profound and comprehensive knowledge in all the volume of the curriculum;

• The use of scientific terminology, stylistically competent and logically correct answers on questions, the ability to draw founded conclusions;

• possession of the tools of the discipline (methods of complex analysis and information technologies equipment), the ability to use them in formulating and solving of scientific and professional tasks, ability to independent solving of complex problems within the curriculum;

• understending of basic and additional literature, which is recommended by curriculum on subjects;

• ability to navigate the major theories, concepts and directions in the study of discipline and to give them a critical evaluation;

• active independent work on a practical and laboratory classes, systematic participation in group discussions, a high level of culture at execution of tasks.

7 points:

• systematic, profound and comprehensive knowledge by all sections of the curriculum;

• the use of scientific terminology (including in foreign languages), linguistic and logically correct answers on questions, the ability to make founded conclusions;

• possession of the tools of the discipline, the ability to use them in formulating and solving of the educational and professional tasks;

• understending of basic and additional literature, which is recommended by curriculum on subjects;

• ability to navigate the major theories, concepts and directions in the study discipline and to give them a critical evaluation;

• independent work on a practical and laboratory classes, participation in group discussions, a high level of culture at execution of tasks

6 points:

• sufficiently comprehensive and systematic knowledge in the volume of the curriculum;

• the use of the necessary scientific terminology, stylistically competent and logically correct answers on questions, the ability to draw founded conclusions;

• possession of the tools of the discipline, the ability to use them in the educational and professional tasks; the ability to independently apply the standard solutions as part of the curriculum;

• understanding the basic literature which is recommended by curriculum on subjects;

• ability to navigate the basic theories, concepts and directions in the study discipline and to give them a comparative assessment;

• active independent work on a practical and laboratory studies, periodic participation in group discussions, a high level of culture at execution of tasks

5 points:

• Sufficient knowledge in the educational standard;

• the use of scientific terminology, stylistically competent and logically correct answers on questions, the ability to draw conclusions;

• possession of the tools of the discipline, the ability to use them in the educational and professional tasks; the ability to independent use in the standard solutions as part of the curriculum;

• undestanding the basic literature which is recommended by curriculum on subjects;

• ability to navigate the basic theories, concepts and directions in the study discipline and to give them a comparative assessment;

• independent work on a practical and laboratory classes, participation in group discussions, a high level of culture at execution of tasks.

4 points:

• sufficient knowledge within the educational standard;

• undestanding of basic literature which is recommended by curriculum on subjects;

• the use of scientific terminology, stylistically and logically correct answers on questions, the ability to draw conclusions without significant errors;

• possession of the tools of the discipline, the ability to use them to solve the standard (typical) tasks;

• ability to solve standard (typical) tasks under the supervision of a teacher;

• ability to navigate the major theories, concepts and directions in the study discipline and evaluate them;

• Working under the guidance of a teacher on the practical and laboratory sessions, the allowable level of culture at execution of tasks.

3 points:

• fairly comprehensive knowledge in the framework of educational standards;

• knowledge of the part of basic literature which is recommended by curriculum on subjects;

• the use of scientific terminology, the presentation of answers to questions with significant linguistic and logical errors;

• poor possession of the tools of the discipline, incompetence in dealing with the standard (typical) tasks;

• inability to navigate the major theories, concepts and directions of the study discipline;

• passivity in the practical and laboratory sessions, the low level of culture at execution of tasks.

2 points:

• fragmentary knowledge within the educational standard;

• knowledge of certain literature which is recommended by curriculum on subjects;

• failure to use scientific terminology in discipline, availability of significant linguistic and logical errors in the presentation of answers to questions;

• passivity in the practical and laboratory sessions, the low level of culture at execution of tasks.

1 point:

• Lack of knowledge and skills within the educational standard or refuse to answer.

3.1.3. The System of State Control of education quality

Training is conducted in accordance with the educational programs as a set of documents, regulating the educational process, and the conditions necessary to obtain a certain level of education in accordance with the expected results of. The main document is the educational standard. Ministry of Education organizes the development of educational standards and training and program documentation.

Educational programs of Belarusian higher education system are implemented by specialties, directions of specialties, specializations, provided the opening of training by them. The procedures for opening training in specialties, directions of specialties and specializations are established by the Government of the Republic of Belarus. Profiles of education, directions of education, specialties, directions of specialties and specializations are determined in accordance with national qualifier of the Republic of Belarus "Specialties and qualifications"

Educational programs of post-graduate education are implemented by specialties corresponding to specialties nomenclature for researchers in Republic of Belarus which are approved by the Higher Attestation Commission of the Republic of Belarus. The procedure for opening of training by specialties for post-graduate education is established by the Government of the Republic of Belarus.

Mastering by trainee of appropriate educational programs content is fixed by the qualification awarding which is confirmed by an approved state document on education. Such documents on education include:

certificate of General Basic Education;

certificate of General Secondary Education;

diploma of Vocational Education;

diploma of Secondary Special Education;

diploma of Higher Education;

master's diploma;

diploma of researcher.

Diplomas of Candidate of Sciences (PhD) are issued on the basis of decision of the Council by Defending of Dissertations approved by the Higher Attestation Commission of the Republic of Belarus; Doctor of Sciences diplomas are issued on the basis of the decisions of the Higher Attestation Commission of the Republic of Belarus at the request of Council by Defending of Dissertations[2].

The right of educational institutions to issue graduates (those who have mastered the content of the educational program with education certificates) is established by the decision on the accreditation of educational institutions. If there is a decision on the accreditation of educational institutions the last will be issued certificate(s) of state accreditation.

[2] The procedure for awarding the degree of doctor of science and candidate of science is determined by the "Regulation of the Higher Attestation Commission of the Republic of Belarus", approved by the Decree of the President of the Republic of Belarus in December 16, 2013 № 560 "Regulations on the awarding of academic degrees and conferring academic degrees in the Republic of Belarus", approved by Decree President of the Republic of Belarus 17.11.2004 № 560 (as amended by the Decree of the President of the Republic of Belarus 01.12.2011 № 561 as of 12.16.2013) and other documents

State accreditation of educational institutions presents the activities of public authorities to establish compliance between the educational activities of the educational institution and education legislation, the content and quality of education provided the requirements of educational standards, training and education programs for program documentation.

State accreditation of educational institutions is carried out for each specialty to conform to the type of activity for these institutions. It inspects:

on relevance of activity to the declared one - in the first year after the creation of the educational institution or changing its form, but not later than four months before the completion of the first graduates;

by the specialty for which educational programs of stage I for higher education (which is alo integrated with education programs of secondary special education) is realized, providing the qualification “Specialist” with higher education - in the third year of the first training in this specialty;

by the specialty, for which educational programs of for stage II higher education, forming the knowledge and skills of teaching and research work, or education program of stage II higher education with more deep training that provides a master's degree obtaining - not later than four months before the end of the first training (re-training) in this specialty.

Educational institution or any other organization that, in accordance with the law, has the right to carry out educational activities must confirm their state accreditation.

Confirmation of state accreditation is carried out:

on conformity to the type of educational activities - not less than one time for five years from the date of receiving of appropriate state accreditation certificate;

on correspondence to the specialty in conjunction with confirmation of state accreditation to conform to the declared activity.

3.2. Transition to differentiated duration of training

Here we shall briefly describe the 5-year training by the Stage I of higher education and the one-year training by the Stage II of higher education for the system "Specialist (5 years) - Master (1 year)" on Faculty of Physics of BSU which supplied the education in Physics for Belarusian research institutions, universities and Hi-teck enterprises.

3.2.1. General information

At the time of entry into force of new Code of Education (December 22, 2010) training period (duration of training) for the majority of higher-education specialties of the Stage I was 5 years and for the specialties of higher education of Stage II - 1 year. Specialties, Standards of Education, the date of their entry into force and duration of training period in which training was carried out at the Faculty of Physics of BSU are presented in Table 1

Table 1

Specialty (direction)	Standard	Date of entry into force	№ of Ministry of Education Decree	Duration of training
1-31 04 01-01 Physics (research activity)	ОСРБ 1-31 04 01-2008	02.05.2008	40	5 years
1-31 04 01-02 Physics (engineering activity)				5 years
1-31 04 01-03 Physics (teaching activity)				5 years
1-31 04 01-04 Physics (managerial activity)				5 years
1-31 04 01-05 Physics (nuclear physics and technologies)	ОСРБ 1-31 04 01-05-2009	15.03.2010	35	5,5 years
1-31 04 01-06 Physics (physics of nanomaterials and nanotechnologies)	ОСРБ 1-31 04 01-06-2011	31.08.2011	249	5 years

According to the Order of the Minister of Education of the Republic of Belarus № 389 from 28.05.2012 the transition to the differentiated duration of training for higher education of the Stage I was performed. To implement programs for education with duration of less than 5 years, Standards of Education, Model Curricula, the Curricula of Higher-education Institutions and related documentation were developed for the most of specialties. Table 2 shows specialties by which the Faculty of Physics of BSU organizes and conducts trainings appropriated to Higher Education of the Stage I. The only exception is the direction of the specialty 1-31 04 01-03 Physics (teaching activity) with a four-year education, for which admission of school-leavers was not carried out and training, at present, was not conducted.

Table 2

Specialty (direction)	Standard	Date of entry into force	№ of Ministry of Education Decree	Duration of training
1-31 04 01-01 Physics (research activity)	OCBO 1-31 04 01-2013	30.08.2013	88	5 years
1-31 04 01-02 Physics (engineering activity)				4 years
1-31 04 01-03 Physics (teaching activity)				4 years
1-31 04 01-04 Physics (managerial activity)				4 years
1-31 04 01-06 Physics (managerial activity)	OCBO 1-31 04 06-2013	30.08.2013	88	5,5 years
1-31 04 01-07 Physics (nuclear physics and technologies)	OCBO 1-31 04 07-2013	30.08.2013	88	5 years
1-31 04 08 Computer physics	OCBO 1-31 04 08-2013	30.08.2013	88	5 years

Completion of education in any of the presented in Tables 1 and 2 specialties of higher education of the Stage I gives the right to graduates to continue their education at the Stage II. Existing Standards of Higher Education (see. Table 3) provide training for the period of 1 year for those master-level students, who were involved into the program of higher education of the Stage I during 5, and 2 years - for those who studied at the Stage I of higher education during 4 years. The Standards describe in detail the case of the one-year study period. The two-year training period was considered only as an option and is not explicitly regulated at present. So, a Model Curricula (see. Table 4) and Curricula of Higher-education for Institutions – University Component (see. Table 5) for specialties of the Stage II were developed now only for one-year training period.

Table 3

Specialty (direction)	Standard	Date of entry into force	№ of Ministry of Education Decree
High Education of the Stage II, forming knowledge, competences and skills of teaching and scientific-research work			
1-31 80 05 Physics	OCBO 1-31 80 05-2012	24.08.2012	108
High Education of the Stage II with in-depth training of specialist			
1-31 81 01 Physics of condensed media	OCBO 1-31 81 01-2012	24.08.2012	108
1-31 81 02 Photonics	OCBO 1-31 81 02-2012	24.08.2012	108
1-31 81 03 Functional Nanomaterials	OCBO 1-31 81 03-2012	24.08.2012	108
1-31 81 04 Physics of condensed media	OCBO 1-31 81 04-2012	24.08.2012	108

Table 4

№	Curricula (Code of specialty, direction)	Date of entry into force	Registration number
1	1-31 80 05 – Physics	30.05.2012	№ G 31-2-005/ mod.
2.	1-31 81 01 – Physics of condensed media	12.07.2012	№ G 31-2-012/ mod.
3.	1-31 81 02 – Photonics	12.07.2012	№ G 31-2-013/ mod.
4.	1-31 81 03 – Functional Nanomaterials	12.07.2012	№ G 31-2-015/ mod.
5.	1-31 81 04 – Current methods and devices for physical measurements	12.07.2012	№ G 31-2-016/ mod.

Table 5

№	Curricula (Code of specialty, direction)	Date of entry into force	Registration number
1	1- 31 80 05 – Physics	30.05.2012	№G31-040/st.
2	1-31 81 01 – Physics of condensed media	30.05.2012	№G31-039/st.
3	1-31 81 02 – Photonics	30.05.2012	№G31-038/st.

In particular for the Stage II training by specialties 1-31 81 03 - Functional Nanomaterials and 1-31 81 02 – Photonics, Model Curricula and Curricula for Higher-education Institutions were not developed for two-years study period. Due to the fact that admission to the Stage II training for specialties 1-31 81 03 - Functional Nanomaterials was not held, the Curriculum of Higher-education Institution was not developed also for one-year training period.

So, to realize the possibility of continuing education at the Stage II of higher education for individuals trained on the Stage I during 4 years (see. Table 2), now we have the goal to develop[3] curricula and related documentation for specialties 1-31 81 03 - Functional Nanomaterials and 1-31 81 02 - Photonics, taking into account the experience of the EU countries and the desire of the Republic of Belarus to join the European Space of Higher Education. The choice of specialties is due to the need for research institutions and Hi-Tech enterprises of Belarus in highly qualified specialists of this profile.

3.2.2. Brief description of the 5-year Stage I of higher education realized on Faculty of Physics of BSU

In accordance with the approved first degree (diplomaed specialist) academic education programme "1-31 04 01 - Physics", since 2012 up to now, a training

[3] In Yerevan, on May 14-15, 2015, the Ministerial Conference of the European Higher Education Area (EHEA) adopted a Roadmap for higher education reform in Belarus. In this regard, changes in the regulatory documents, governing the opening of the training by specialties for both I and II stages, the procedure of development and approval of educational-program documentation are possible. Accordingly, in the course of the project implementation, we shall be forced to change the procedures of approval for teaching/studying documentation and its inventory.

was carried out on 1-2 courses by the general program and on 3-5 courses by the Diplomaed Specialist Programme (for 4 qualifications - "research activity", "engineering activity", "teaching activity", "managerial activity"). During 2-5 courses this training was also carried out additionally in the areas of 14 specializations (depending of Chair).

The aims and objectives of the Specialist academic educational programme "1-31 04 01 - Physics" have not been changed principally since 2008. To start the specialist academic studies (on the 1st year), secondary school or gymnasium education in the area of physics, mathematics and language (Russian or Belarusian) were required. This programme was based on the Educational Standard of Republic of Belarus OCPB 1-31 04 01-2008 whose main positions are presented below.

The main goals and deliverables of the Specialist academic studies are social and professional competences, which allow him:

- To combine the academic, professional, social and personal competencies to meet the challenges in the field of professional and social activities;
- To carry out the research work of the theoretical and experimental nature, aimed at the study, analysis and practical use of the physical processes in various fields of research and engineering, including the improvement and development of new approaches to the solution of physical problems of modern science, technology, power, manufacturing and management;
- To maintain a highly qualified teaching and training work in educational institutions of secondary, specialized secondary and higher education;
- To carry out the planning and organization of scientific-practical, research, development, engineering, managerial, marketing and financial activities.

The tasks of professional activity:

- An experimental study of the physical processes at different levels of structural organization of matter at different physical conditions;

- The study, the theoretical analysis of physical effects and phenomena, the prediction of new physical laws based on modern theoretical concepts, mathematical and computer methods;
- The development of devices based on physical principles and new materials;
- Research work in the fields, using mathematical methods and computer technology;
- The creation and use of mathematical models of processes and objects;
- The development of efficient mathematical methods for solving problems of natural science, engineering, economics and management;
- Definition of the objectives of innovations and ways to achieve them;
- Software and information support of scientific research, engineering design, operational and management activities;
- The teaching of physical and mathematical sciences (including computer science);
- Planning and organization of scientific-practical, research, development, design, project management, marketing and finance;
- Development of projects, contracts, budgets, reports and other documents;
- Preparation of research papers, drafting essays, surveyes, reviews.

The composition of competencies

Specialist training should ensure the formation of the following groups of competencies:

- academic competencies, including knowledge and skills on the studied subjects, skills and abilities to learn;
- social and personal skills, including cultural value orientation, knowledge of the ideological and moral values of the society and the state and the ability to follow them;
- professional competencies, including knowledge and skills to address the problems, solve problems, develop plans and ensure their implementation in the chosen professional field.

- Requirements for the level of training of graduate

General requirements for the level of training:

- The graduate should have an adequate level of knowledge and skills in the field of social and humanities, natural sciences, of general and special subjects, specialization subjects for the implementation of social and professional activities.

- The graduate should be able to continuously improve their knowledge, analyze historical and contemporary issues of socio-economic and spiritual life of the community, to know the ideology of the Belarusian state, moral and legal norms, to be able to integrate them into their life.

- The graduate should possess state languages (Belarusian, Russian), one or several foreign languages, be prepared for constant professional, cultural, and physical self-improvement.

Requirements for the academic competence

The graduate should possess the following academic competencies:

- To possess and apply the basic scientific and theoretical knowledge to solve theoretical and practical problems;

- Possess a systematic and comparative analysis;

- Possess research skills;

- Be able to work independently;

- Possess an interdisciplinary approach in solving problems;

- Have the skills associated with the use of technical devices and work with a computer;

- To have the linguistic skills;

- To be able to learn, improve their skills throughout their lives;

- Formulate and solve problems arising in the course of scientific research, engineering and teaching.

Requirements for the social and personal competences

The graduate should have the following social and personal competences:

- Possess the quality of citizenship;
- To be able to social interaction;
- Be able to interpersonal communication;
- To be able to self-criticism and to accept criticism;
- Be able to work in a team.

Requirements for the professional competencies

The graduate should possess the following professional competencies by type of activity, be able to:

in research activity:

- Apply their knowledge of the fundamental principles of physics, experimental, theoretical and computer methods of the study, methods of measurement of physical quantities and methods of evaluation of measurement errors, planning, organizing, and conducting research;
- Use the latest discoveries in science, methods of scientific analysis, the physical basis of modern technologies, scientific equipment and apparatus in research;
- Use computer methods of data collection, storage and processing of information, systems, automated programming, the new scientific, technical and patent literature on the physics and technology innovation, skills, self-education and self-improvement;
- To develop new technologies based on mathematical modeling and optimization;
- Define the objectives of innovation and how to reach them;
- Interact with related professionals;
- To negotiate, develop plans for cooperation with other organizations;
- Prepare reports, materials for presentations and act as representative on them;
- To use the global information resources;

in engineering (industrial) activity:

- Apply knowledge of the theoretical and experimental foundations of physics, research methods, methods of measurement of physical quantities, methods of planning, organizing, and conducting research and production and development work, automation, legal support economic activity and the tax system, government regulation of the economy and economic policy;
- Use computer methods of data collection, storage and processing of information, systems, automated programming, the new scientific, technical and patent literature in physics, economics, and innovative technologies, the basics of psychological and pedagogical knowledge, skills, self-education and self-improvement;
- Implement, basing on mathematical modeling, assessment of the economic and financial situation;
- Interact with related professionals;
- Apply the methods of analysis and organization of innovation;
- To assess the competitiveness and cost-effectiveness of emerging technologies;
- To negotiate, develop plans for cooperation with other organizations;
- To use the global information resources;

in teaching activity:

- Have knowledge about the structural organization of matter, fundamental physical laws, phenomena and effects, modern scientific methods of learning of the nature, methods of measurement of physical quantities and methods of evaluation of measurement errors;
- To use the fundamental principles of physics, the conceptual provisions of pedagogy and methodology of teaching in physics and computer science, methods of educational work, teaching aids;

- Use computer-based data collection, storage and processing of information, psychological and pedagogical knowledge, effective forms and methods of teaching, new learning technologies;

- Use of automated programming systems, new scientific, technical and patent literature on the physics and technology innovation, skills for self-education and self-improvement;

- Define the objectives of innovation and how to reach them;

- Interact with specialists from related sciences;

- Prepare reports, materials for presentations and act as representative on them;

- To use the global information resources;

in managerial activity:

- Apply knowledge of the physical foundations of modern technology, automation, planning methods, organization and conduct of the proceedings, legal support economic activity and the tax system, the modern enterprise, government regulation of the economy and economic policy;

- To use the discovery in the natural sciences, the principles of environmental management for the calculation of the efficiency of design and engineering solutions based on market conditions;

- Use computer methods of data collection, storage and processing of information, systems, automated programming, the new scientific, technical and patent literature on physics, economics and technology innovation, skills, self-education and self-improvement;

- Be based on mathematical modeling assessment of the economic and financial situation;

- Know the labor laws;

- To organize the work of a group of performers in order to achieve the set goals, plan funds pay;

- Apply the methods of analysis and organization of innovation;

- Interact with related professionals;
- To assess the competitiveness and cost-effectiveness of emerging technologies;
- To negotiate, develop plans for cooperation with other organizations;
- Prepare reports, materials to presentations and act as representative on them;
- To use the global information resources.

3.2.3. Brief description of the educational program for higher education of Stage II with one-year training period for the specielties for which the training is carried out at the Faculty of Physics of BSU

3.2.3.1. General characteristics of the specialties 1-31 81 02 - Photonics and 1-31 81 03 - Functional Nanomaterials.

Specialties 1-31 81 02 1-31 81 Photonics and 03 - Functional Nanomaterials in accordance with OKRB 011-2009 are related to the profile of education, "Natural Sciences", direction of education of 31 "Natural Sciences" and provide the obtaining of a Master`s degree in Physics.

Admission to training takes place on a competitive basis. The level of basic education for the coming individuals is higher education of Stage I by group of specialties "Physical Sciences". In the case of presence of the I Stage higher education by other specialties, persons should participate in contest with a glance of results of additional examinations on subjects, the list of which is determined by the higher education institution.

Form of education is full-time (day).

Timing of the Stage II of higher education:

1 year - for persons trained by the program of the Stage I of higher education during 5 years or more;

2 years - for persons trained by the Stage I of higher education during 4 years.

Main areas of professional activity of the Master's graduate includes education, research and development.

The main objects of professional activity: the laws of physics, mathematical models and methods of physical objects and processes; measuring and technologic equipment, automation systems used in a physical experiment, the production of materials and devices; physical control methods combined with mathematical modeling methods; educational systems, pedagogical processes, training and methodological support of physical-mathematical disciplines.

The main tasks of professional activity of graduates of Masterships:

 preparing and conducting of classes in the physical-mathematical disciplines including higher education institutions, the management of scientific research work, the development of training and methodological support of educational process;

 planning and carrying out research in the field of physics and engineering;

 development of recommendations on the use of progress in physics and advanced technologies in industry, education, patenting activity, the development of scientific and technical documentation;

 application of modern design methods, the use of automation of physical experiment, the production of materials and devices;

 analysis of economic activities of research institutions and companies working in the field of high technologies;

 development of plans and programs of innovation, feasibility study of innovative projects.

In accordance with the model curriculum for master's degree in higher education programs of the II Stage with in-depth training, which is designed on a one-year training period, the work content of training corresponds to 60 credits. In so doing, 18 credits are given on the study of the cycle of special training disciplines, including 5.5 credits on the State Component and 12.5 credits on a Higher-Eeducation Institutions Component. Preparation for exams on special subjects gives 6 credits, research work - 22.5, practice - 4.5, final examination - 9.

The practical training is aimed at strengthening the knowledge and skills acquired during the theoretical training in the masterships, the acquisition of practical skills in solving educational, research-production and technological activities, preparation of the master's thesis.

Final certification provides for the defending of master's thesis. Master's thesis addresses the theoretical, experimental and applied problems in branches related to teaching, research, or industrial and technological activities. It should contain the scientific review and research part, which reflect the professional competence of the Master's graduate in accordance with the training. The research part should be at least 70% of the thesis. In preparing the master's thesis graduate must demonstrate the ability to solve the problem at the present level of professional activity, the ability to integrate scientific knowledge and argue his viewpoint.

3.2.3.2. Features of specialty 1-31 81 02 – Photonics

In addition to general economic, social and personal competencies Master of Physics by specialty 1-31 81 02 - Photonics should have the following most important professional competencies:

 to formulate and solve problems in the study of the processes of generation, amplification, modulation, propagation and detection of optical signals;

 to carry out qualified theoretical research in the field of photonics;

 to use the latest discoveries in the natural sciences, the physical basis of modern technological processes including nanotechnology;

 to apply the knowledge of theoretical and experimental foundations of optics and spectroscopy methods for the study of physical objects, methods of measurement of physical quantities, methods of the experiment automation, methods of planning, organization and conduct of research and production, production and technical development at creation of systems for generation, amplification, modulation, spreading and detecting optical signals;

 using mathematical modeling to perform estimation of operating parameters of materials and technological processes for their production.

The State Component of the model curriculum provides the study of discipline "Nanophotonics", including the following topics: nanostructures, methods of nanomaterials production, the advanced fields of application of nanomaterials, photonic crystals, nonlinear optical effects in photonic structures (self-focusing in periodic structures, parametric interaction of light waves, optical solitons), modeling of light propagation in periodic and quasi-periodic nanostructures, nanoplasmonics, nanoplasmonic applications, the optical properties of semiconductor nanoparticles and structures, optics of quantum wells and superlattices, quantum microcavities, metamaterials.

As a result of the discipline undergraduate has:

to know:

- the application of nanophotonics;
- the physical basis of nanophotonics and optical nanostructures;
- experimental methods and basic design of instruments used in nanophotonics;
- theoretical models in the field of nanophotonics and their applicability;
- physical mechanisms of interaction of electromagnetic radiation with nano-structures.

to be able to:

- include the acquired knowledge in the field of nanophotonics (spectroscopy and photophysics of nanostructures) into the existing system of knowledge and to apply this knowledge in independent development;
- to transfer the knowledge gained in the field of nanophotonics on related subject areas and to use them for preparation of new objects of engineering and technology.

Content of disciplines for the Component of Higher-Education Institutions, elective courses at the choice of a master-student, requirements for the competence of these disciplines are established in curricula of higher education institutions by appropriate academic disciplines, in accordance with an individual plan of work of a muster-student.

3.2.3.3. Features of specialty 1-31 81 03 – Functional nanomaterials

In addition to general economic, social and personal competencies Master of Physics by specialty 1-31 81 03 - Functional Nanomaterials should have the following most important professional competencies:

 to formulate and solve experimental problems associated with the study of the structure, the electrical, optical and mechanical properties of nanomaterials;

 to carry out qualified theoretical research in the field of materials science;

 to use the latest discoveries in the natural sciences, the physical basis of modern technological processes, including nanotechnology, to create new functional materials;

 to apply the knowledge of theoretical and experimental bases of condensed matter physics, the study of methods of physical objects, methods of measurement of physical quantities, methods of the experiment automation, methods of planning, organization and conduction of research, production and technical development work;

 to perform on the base of mathematical modeling estimation of operational characteristics of functional nanomaterials and processes for their preparation.

The State Component of the model curriculum includes the study of discipline "Nanostructured materials and methods of their investigation," including the following topics: low-dimensional systems, classical and quantum-sized effects, the manifestation of size effects in the physical properties of nanomaterials and devices, transmission and scanning electron microscopy, X-ray photoelectron spectroscopy, a far x-ray absorption fine structure, the method of Rutherford backscattering, neutron depth profiling, method of implantation-induced fluorescence analysis (PIXE), scanning tunneling microscopy, optical near-field microscopy, electron spectroscopy and nuclear magnetic resonance, Raman scattering of light.

As a result of the discipline undergraduate has:

to know:

- the basic concepts of physics of low-dimensional systems and nanostructured

materials;

- physical principles of electron and ion-probe methods of investigation, optical spectroscopy, tunneling and atomic force microscopy;

- the application of nanomaterials and nanostructures;

to be able to:

- choose the most informative methods of research of nanostructures and nanomaterials;

- describe electrical, magnetic and optical properties of nanomaterials based on their atomic structure;

- determine the use of nanomaterials based on their electrical, magnetic and optical properties.

Content of disciplines for the Component of Higher-Education Institutions, elective courses by the choice of Master student, requirements for the competences by these disciplines are established in Curricula of higher-education institutions for various academic disciplines, in accordance with an individual plan of work of a master student.

3.3. SWOT analysis of one-year programme of higher education of the Stage II with in-depth training of specialists

S - the strong sides of the programme realization

1. Education at the Stage II begins after 5-year training programme fulfilling that allows one to concentrate on further specialization and research work during the master degree preparation.

2. The warranty of succession and continuity in the mastering of disciplines for the one-year training by the Stage II of higher education by the system "Specialist (5 years) - Master (1 year)": from fundamental training in mathematics and physics (at the beginning of the Stage I of training) - to highly specialized disciplines (in the the Stage II). The following main components of fundamental education in the field of physics can be singled out:

 mathematical training;

 training in the disciplines of general physics;

 training in the disciplines of theoretical physics;

 training in the field of information and computer technologies;

 training on special subjects (both in the areas of specialties (e.g, engineering and managerial activities, and so on) and within the framework of specialization (e.g, laser physics and spectroscopy, biophysics, physics of semiconductors, nanoelectronics, etc.), the study of which provides the formation of skills for application of fundamental knowledge in practice.

As a consequence:

2.1. The high level of fundamental training in physics and mathematics of the Stage II graduates;

2.2. The high level of mastering of special disciplines by graduates of the Stage II in optics and laser physics for a specialty - 1-31 81 02 Photonics and in condensed matter physics and semiconductor physics - for the specialty 1-31 81 03 - Functional Nanomaterials.

3. The high scientific level of master's theses, achieved through good training (at the initial level of specialist), significant time devoted to research work, and continuity in the conduction of research work by master students from course works and diploma theses (at the Stage I) - to the master's thesis (in the Stage II).

4. Relatively short period of training, which allows to reach the level of training of the same, or even higher, results, than for the system "Bachelor (4 years) - Master (2 years)."

5. In general, the training at the Stage II is aimed on preparation of specialists which can work in research institutions and universities with the possibility of post-graduate studies.

W - the weak sides of the programme realization

1. The content and timing of training by the one-year educational program at the Stage II of higher education and training as a whole by system "specialist (5

years) - Master (1 year)" do not fit naturally into the system of the European Higher Education Area.

2. The content and timing of training by the one-year educational program at the Stage II of higher education currently are not matched with the system of a Joint Educational Space of the Eurasian Economic Union and this discrepancy increases with the time running.

3. The difficulties in adapting the curricula for foreign students.

4. Excess training period for a bachelor's degree preparation in the Stage I and the need for further harmonization of curricula for the Stage II of higher education for foreign students.

5. Even for the Stage II of higher education with in-depth training, it is traced the preferred orientation of training on the research area, probably with some damage to the interests of the industry (although the current system needs of the industrial enterprises completely met by graduates with a diploma of specialist).

6. Orientation of educational programs on the sphere of science does not allow to establish sufficiently strong ties with industry.

O - opportunities outside the university

1. Compliance with the one-year education program at the Stage II of higher education and training as a whole by system "Specialist (5 years) - Master (1 year)" needs and requirements of the major employers in the scientific field.

2. Compliance with the historical traditions.

3. Compliance with the prevailing psychological stereotypes in society and social needs.

4. Eleven-term general secondary education in general is agreed with the system of "Specialist (5 years) - Master (1 year)." The lack of special training of school-graduates to study at the universities and their relatively low level "on entrance" of higher education is offset by a large period of higher education in the Stage I.

5. Conducting of weighted and careful public policy in relation to entry in the

European Higher Education Area in the period 1999-2015.

T - threats of the successful realization of the programme

1. In general, the system of training by system "Specialist (5 years) - Master (1 year)" limits the possibilities for the export of educational services to the countries outside the Eurasian Economic Union.

2. Joining to the European Higher Education Area of the Eurasian Economic Union countries, with which the Republic of Belarus have close economic ties and in fact the single job market:

2.1. limits the interest of citizens of these countries in higher education in the universities of Belarus;

2.2. severally narrows the possibilities for employment of graduates of Belarusian universities in these countries.

3. The lack of a clear understanding of the place of graduates with a master's degree and their professional duties in industrial and technological companies, reduces the interest of industrial enterprises to such graduates.

4. Weak links with industry and the lack of social order for the Masters outside the scientific sphere leads to a decrease in the number of those wishing to continue their education in the Stage II by one-year educational program.

5. Existing administrative restrictions on the admission on the Stage II of higher education (merely about 7 % per cent of the graduates of the Stage I) does not stimulate the progress of the education on the Stage II.

3.4. Proposals for a two-year educational programmes of higher education for the second stage with in-depth training for specialties 1-31 81 02 1-31 81 Photonics and 03 - Functional Nanomaterials

3.4.1 Basic requirements for a two-year educational programmes to be developed

The developed programmes should provide:

1. Minimizing of losses in the content of the curricula, pre-existing in the system of "Specialist (5 years) - Master (1 year)";

2. A high level of basic training graduates of the Stage I in mathematics and physics;

3. The possibility of in-depth specialization in the Stage II of higher education;

4. Extensive training in applied physics to enhance staff potential of industrial enterprises;

5. The possibility of practical training both for research and industrial sectors;

6. The conditions for maintaining the high scientific level of master's theses;

7. Variability of in-depth specialization during the Stage II of higher education, using both disciplines of Component of Higher-Education Institutions and through elective courses by the choice of students;

8. Possibilities to develop export of services in the field of higher education.

3.4.2 A rough list of subjects to be included in the curriculum for the development of a two-year educational programmes

According to the educational standard OCBO 1-31 81 02-2012 and model curriculum № G 31-2-013/model the State Component of the cycle of disciplines for special training includes the following disciplines: Philosophy of physics and the technosphere, Nanophotonics, Pedagogy and psychology of higher education.

In the development of a two-year educational programme of the Stage II of higher education by the specialty 1-31 81 02 Photonics in the curriculum is supposed to include subjects such as: Modern ideas about the structure of matter,

Problems of Applied Physics, Additional chapters of quantum mechanics, the theory of symmetry groups, Spectra and molecular structure, Physics of biological systems, Wave physics, Nonlinear physics, Simulation in physics, Quantum optics, Photonic crystal optics, Polymers and liquid crystals, Computer simulations in optics and spectroscopy.

Educational standards OCBO 1-31 81 03-2012 and model curriculum № G 31-2-015/model provide for the study of the following disciplines of special training within the State Component: Philosophy of physics and the technosphere, Nanostructured materials and methods of their research, Pedagogy and psychology of higher education.

In the development of a two-year educational programme of the Stage II of higher education by the specialty 1-31 81 03 - Functional Nanomaterials, it is supposed to include to the curriculum the following subjects: Modern ideas about the structure of matter, Problems of Applied Physics, Additional chapters of quantum mechanics, The theory of symmetry groups, Physics of biosystems, Physics of wave processes, Nonlinear physics, Simulation in physics, Physics and chemistry of the surface, Selected chapters of physics and technology of semiconductors, Physics of low-dimensional systems, Technologies and materials in nanoelectronics, Energyefficient technologies and materials, Nanobio-technologies, Microsensor systems, Electronics and programming of microcontroller systems.

Curricula, which should be developed for specialties 1-31 81 02 - Photonics and 1-31 81 03 - Functional Nanomaterials for two-years Master-level programmes, will have the following distribution of educational work:

- A set of special training courses - 56-68 %
- Research work - 15-20 %
- Practice - 4-12 %
- Final examination - 7-10 %

When developing the curriculum of Higher-Education Institutions is expected to provide some elective disciplines by the choice of a student containing about 20

to 50 % of the number of teaching hours allocated to the Component of Higher-Education Institutions. As an intermediate stage of preparation of the master's thesis is supposed to write a course work.

3.5. Suggested work plan

A reformation of Belarusian high education system according to Bologna process (transition to cycle system, credit transfer, diploma supplement, etc.) is the wide project goal. The topics of the model curricula will be developed and transformed to comply with ECTS standards, in order to make transfer of credits and the implementation of bilateral contracts feasible regarding the content and organisation of study programs.

In respect to specific needs identified in the previous sections, the target is to upgrade master-level education (Stage II) in the field of functional nanomaterials and photonics in BSU according to Bologna practices in physical science, to enhance the quality and relevance of education using modernised study programs, focusing on the use of ICT, and through networking activities in respect to the labour market needs

The suggested work plan will be directed on the resolution of the following issues:

1. Development of modern master-level programs in the field of functional nanomaterials and photonics, which will respected principles of the Bologna process, and their implementation in Faculty of Physics of BSU;

2. Development and update courses and didactic materials within master-level model educational programs and study programs by Functional nanomaterials and Photonics;

3. Improvement academic staff competences on Faculty of Physics of BSU for teaching of developed courses by functional nanomaterials and photonics;

5. Imnplementation of modern technical infrastructure for teaching and learning in the field of functional nanomaterials and photonics.

6. Development of innovative ICT based teaching and learning environment for improved teaching in the field of functional nanomaterials and photonics;

7. Promotion to making closer of master-level graduates in the field of functional nanomaterials and photonics to the Labour Market needs.

Before development of new model curricula and study programs, the studies to define specific needs of the labour market in the field of functional nanomaterials and photonics will be conducted. The studies will be achieved using contribution of other Belarusian partners of the project, including Belarusian Association of Nanoindustry, Belarusian Physical Society, Ministry of Education and also associated partners, through consultations with them, conducting surveys and questionnaires and also visits to other Belarusian universities, research institutes and enterprises.

Specifically acquisition of practice-oriented model curricula and study programs in the field of functional nanomaterials and photonics will be supported by virtual/on line laboratories and dedicated hardware/software platform developed on the purchased equipment.

As the main results of the project, we shall develop two model curricula, which will include Model (standard) educational programmes for two specialties (Functional nanomaterials and Photonics) and also training courses in the field of functional nanomaterials and photonics for two course-components – the State (mandatory) Component and the University Component.

Compatible study programmes (including lecture courses, laboratory classes and appropriated didactic materials) will be supported by 5 electronic books developed:

1. Applied Physics.
2. Functional nanomaterials.
3. Photonics.
4. Applied Informatics.
5. Research towards master thesis/ scientific project management.

New master-level programmes (both model curricula and study programs) will be tested during 2 years.